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SOCIAL–TRAFFIC DATA FOR MESOSCOPIC TRANSPORT MODEL

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Gathering the social and traffic data is an essential step in the process of traffic relations calculations in the area of interest. The article deals with the way of social traffic data gathering in Slovak cities. The first part defines the boundary conditions for data gathering. The amount of information obtained from each respondent depends on the number of questions asked in the survey, as well as the depth of the questions asked. Mobility surveys have been done for three Slovak cities – Žilina, Trenčín and Martin. The detailed description of data gathering and evaluation is shown for Žilina. The real ways of data gathering and other experiences are presented in the next part of article. Finally, some examples from evaluation of mobility survey are presented. The survey results are used for calculation of the origin-destination matrices for several transport modes.

Keywords: mobility survey, mobility, data evaluation, transport model

1. Introduction

Designing and implementing a survey is a systematic process of gathering information on a specific topic by asking questions to individuals and then generalizing the results. Gathering the social and traffic data is an essential step in the process of traffic relations calculations in the area of interest. The choice and quantity of enquired inhabitants selected in the sampling process indicates the quality and reliability of results. The article deals with the way of social and traffic data gathering in Slovak cities. The first part defines the boundary conditions for data gathering (the exact specification of survey type, mode of processing and the right definitions of sample of enquired persons). Selected sample of respondents has to represent all habitants.

The quantity of collected data is a function of the number of respondents in the final dataset and the amount of information obtained from each respondent. It presents a trade-off situation because any attempt to collect more information from each respondent (beyond a threshold level of information) may result in less respondents responding. The total number of respondents obviously depends on the size of the sample drawn from the population and the response rate obtained from that sample. The amount of information obtained from each respondent depends on the number of questions asked in the survey, as well as the depth of the questions asked. Thus some surveys can be effective with only a large number of highly directed questions, while others need to explore a few topics in depth. One part of article is dedicated to mathematic formulas for calculation of needed sample, the number of enquired people respectively.

Detailed description of gathering and evaluation is shown for Žilina, where the mesoscopic transport model has been in practice for 5 years. Žilina has more than 82 000 inhabitants. It is the fourth largest city in Slovakia. The city is a natural center for large gravity area, which includes more than 900.000 inhabitants.

2. Traffic Model of Žilina

The complex multi-modal transport model for Žilina city has been created with PTV VISION modules (Fig. 1). VISEM performs the trip generation (calculation of originating travel demand), trip distribution (specification of destinations) and transport mode choice for travel demand calculations. VISUM integrates all relevant modes of transportation into one consistent network model. It provides a variety of assignment procedures and 4-stage modelling components, which include trip-end based approaches as well as activity based ones 3.

This article focuses on socio-traffic data gathering for mesoscopic model. Generally the mesoscopic models are at an intermediate level of detail, for instance describing the individual vehicles, but not their interactions. The level of detail in simulation models ranges from macroscopic, via mesoscopic, to microscopic. Macroscopic models describe the traffic at a high level of aggregation, as flow (number of vehicles per hour that pass a certain point), without considering its constituent parts (vehicles), whereas microscopic models describe the behaviour of the entities making up the traffic stream (vehicles) as well as their interactions in detail [5]. Our model of Žilina city includes also data gathered for microscopic simulation. This issue is not described in this article.

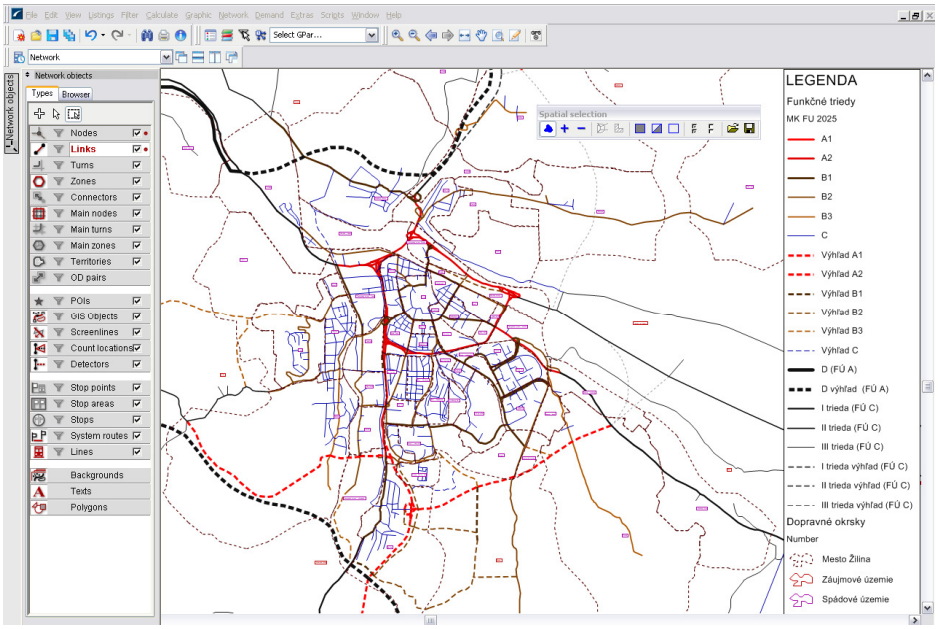

Figure 1. Transport model of Žilina [1]

The traffic modelling allows good understanding of real and potential traffic flows and patterns throughout the network; thereby allowing particular solutions to be developed and assessed in terms of their impact in addressing expected demands 2. The input data of Žilina region is proceeded from the transport-sociological analysis.

3. Definition of Household Mobility Survey

Household travel surveys continue to be an essential component of transport planning and modelling efforts [1].There are not any official standards for household travel surveys in Slovakia and usually it is difficult to explain the importance of survey to investor, let alone its procedure and range. However, it is possible to use many foreign examples or research projects.

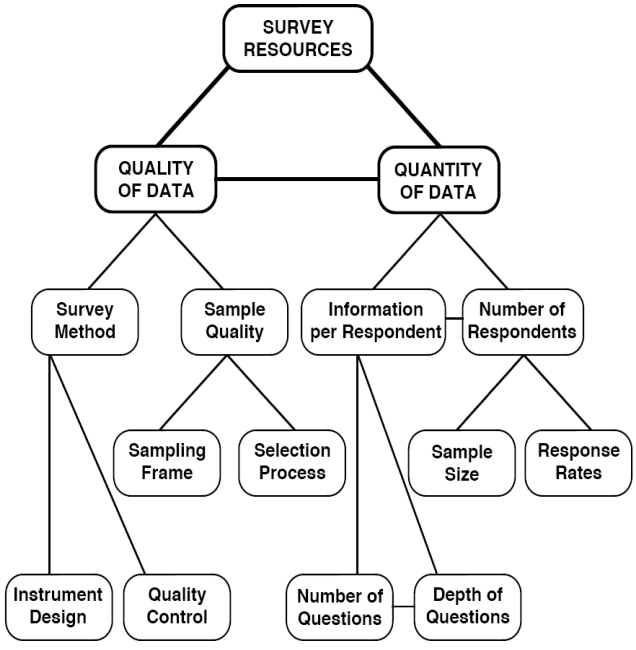

Figure 2. Trade-offs in transport survey process [1]

The quality of collected data is a function of the survey method and the quality of the sample (insofar as the sample is free of bias). The quality of data obtained from any survey method will be, in turn, a function of the quality of the survey instrument design (i.e. it collects information on the variables of interest in an unbiased way) and the quality control procedures put in place for the implementation of that survey method (i.e. what follow-up procedures will be used to verify the quality of the data collected). The quality of the sample will depend on the ability of the sampling frame to represent truly the population, and the extent to which the sample selection procedures result in a random selection from the sampling frame.

The quantity of data collected will be a function of the number of respondents in the final dataset and the amount of information obtained from each respondent. This, in itself, presents a trade-off situation because any attempt to collect more information from each respondent (beyond a threshold level of information) may result in less respondents responding. The total number of respondents will obviously depend on the size of the sample drawn from the population and the response rate obtained from that sample. The amount of information obtained from each respondent will depend on the number of questions asked in the survey, as well as the depth of the questions asked. Thus some surveys can be effective with only a large number of highly directed questions, while others need to explore a few topics in depth. The extent of this trade-off is therefore a specific design decision on the part of the survey designer. The trade-off will also be partly determined by the respondents themselves. As the length of the survey increases, the response rate will generally decrease (the rate of decrease will depend on such factors as the interest level of the survey topic to the respondents, and the overall quality of the survey instrument design). There will therefore be a point at which an increase in the number of questions asked will result in the collection of less data in total, because of the more than proportional decrease in the response rate. The survey designer should therefore be cognizant of this interaction when making the explicit trade-off between the number of respondents and information obtained per respondent.

4. Minimum Survey Sample

Sample design is always a compromise, aiming to achieve maximum final sample efficiency-achieving optimal precision by using all available means and taking the existing limitations into account. It is often the case that the survey client´s first question related to how large a sample is needed for the survey the client wishes to have done. Alternatively, the client may ask if a particular sample is large enough. A definitive answer cannot be given to either question. Sample size is a complex problem that cannot be solved easily, and the answer to this question depends on many things. When dealing with a defined target population, to determine the necessary size sample, the things we need to know are:

- What is to be measured?
- How precisely should it be measured?
- Is it reasonable to assume that the population is homogenous relative to the desired measures?
- Are sample elements to be chosen individually or in groups?

The first and basic steps for design of mentioned survey is understanding its weight. In general, the mobility survey is summation of the activities, which detect information about the traffic process in the solved area. The reason for made survey is gathering the data for traffic planning, projecting and for modernization of transport network [4].

The mobility survey is a separate kind of traffic survey, which is aimed at describing the socio-demographic data and people's behaviour in the traffic process, in the solved area. The database provides the picture of daily function of trips number. The survey is anonymous and it is classified in the progress methods of traffic data gathering. It allows access to global data of all transport modes, transport division, mobility of inhabitants and other socio-traffic data. All of mentioned data are very useful for estimation of traffic prognosis state.

In general, the socio-traffic surveys have to answers the questions as follows [2]:

- Who (the groups of inhabitants)?
- From where (origin zones)?
- To where (destination zones)?
- When (the time function of transport modes variation)?
- How many (volumes of vehicles, persons, freights)?
- Of what (the traffic flow composition)?
- How much (the economic view)?
- Why (the purpose of trip)?

The preparation of survey can be divided into two steps. The basic task for the first step is to divide the solved areas objectively and traffic proportionally. The representative sample is determined in the second step. This step is very important and it cannot be underestimated. The results are not applicable in case of small sample. The number of asked people or households has to be representative. The size of sample might be set empirically or by using formulae. The detailed division of demanded data is then next important step of mobility survey method, because of the realistic projection of all activities. Different groups of inhabitants do not do the same activities. It is necessary to take this fact into account when dividing inhabitants into the social groups.

The questionnaire for mobility survey in Žilina has been divided into three parts. One questionnaire has been destined for one household. The first part contained household data, for example the address, the number of the household members, and ownership of means of transport...). The personal data (in terms of impact on traffic process) have been gathered in the second part. The most important part is the third one. It contains the data about trips, transport mode choice, travel time, activities, purpose of trips, trips chains, and so on.

The selection of sample has to respond to demand data. The expression below presents the necessary number of asked people [2].

$$n = \frac{V^2}{\gamma^2 + \frac{1}{N'} * V^2}, \tag{1}$$

where:

$$V^2 = \frac{1-\pi_A}{\pi_A}, \tag{2}$$

$$\pi_A = \frac{1}{number\_of\_possible\_answers}, \tag{3}$$

n is a necessary number of asked people,

N' is a number of inhabitants,

γ is a allowable mistake.

The practical applications of the presented equations are presented in the next part, where the basic conditions for household mobility survey are described. We have considered the combinations of two groups of demand data – social groups and traffic modes usage.

Table 1. Basic conditions for calculation of sample

Groups of inhabitants		Transport modes	
E+c	Employed persons – car available	Foot	(on foot/walk)
E-c	Employed – no car available	CarPass	(car passenger)
NE+c	Not Employed persons – car available	PuT	(public transport)
NE-c	Not Employed – no car available	Car	(car driver)
Child	Children	Bike	(bicycle)
Stud	Students		
Pens	Pensioners		

We can calculate the necessary sample for household mobility survey according to equation above for these conditions.

Table 2. Sample for household mobility survey

Scenario	Demand data	Number of possible answers	Parameters			% of asked people
			π_a	V^2	n	(n/N)*100
A	number of transport modes	5	0,2000	4	1571	1,84
B	number of inhabitants' groups	7	0,1429	6	2334	2,73
C	**combination of scenarios A and B**	**35**	**0,0286**	**34**	**11734**	**13,72**
D	number of traffic zones	60	0,0167	59	18497	21,62

The scenario A points on survey, which includes only demand for data of determination of traffic modes. In fact, it needs to ask only 1.84% of sample. The scenario B considers number of inhabitants' groups. We defined seven basic groups according to the impact of their traffic behaviour. The combination of scenarios A and B creates the new scenario C. This scenario represents our demand for socio-traffic survey. The value 13.72% sets the size of sample, respectively asked people. The scenario D is only an illustrative example for the area, where there is no information about inhabitants in traffic zones.

We decided to use scenario C by reason to objectively estimate the real relations in transport process. Each habitant fills in the form his/her own home address and the addresses of his/her daily activities. For this reason we do not calculate the scenario D.

5. Mobility Data Gathering

The mobility surveys have been done only in two cities – in Žilina and Trenčín during the last five years. We are preparing a new survey in the city of Martin at present. This city is only 20 km far from Žilina, but its position and character is very different compared to Žilina. We plan to perform the socio-traffic survey in September 2012. The experienced person can fill the questionnaire with the enquired person during 10 minutes. We have used several methods for data gathering to be sure about the survey results. The successful method is a direct meeting (face to face) with the members of family at the doorstep (approximately 53%). The survey has also been successful in the public buildings (the waiting room in the health centres, the client centre in the town hall, bus and railway station, etc.) The success with the filled questionnaires is nearly 40%. We also have used the online questionnaire but it is necessary to take into account the job position of people filling the questionnaire. This sample is not representative and data are often incomplete or understood in a wrong way.

The final sample represented 5011 inhabitants, that is 6% of the total number of inhabitants. Data gathering has been continued with the aim to reach the sample of 13% of total city population.

The obtained experiences will be very useful for the household mobility survey planned for September 2012 in the city of Martin.

6. Evaluation of Household Mobility Survey

The evaluation of the mobility survey is a time-consuming process. The base is a file with all data with the possibility of personal settings.

The following data has been evaluated:

- socio-traffic composition of inhabitants;
- transport mode choice by distance;
- mobility;
- time of starts of trips;
- multiplicity of trips by the purpose during the day;
- comparison of results with mobility survey done in 2007.

In the following part some examples from results of household mobility survey are shown.

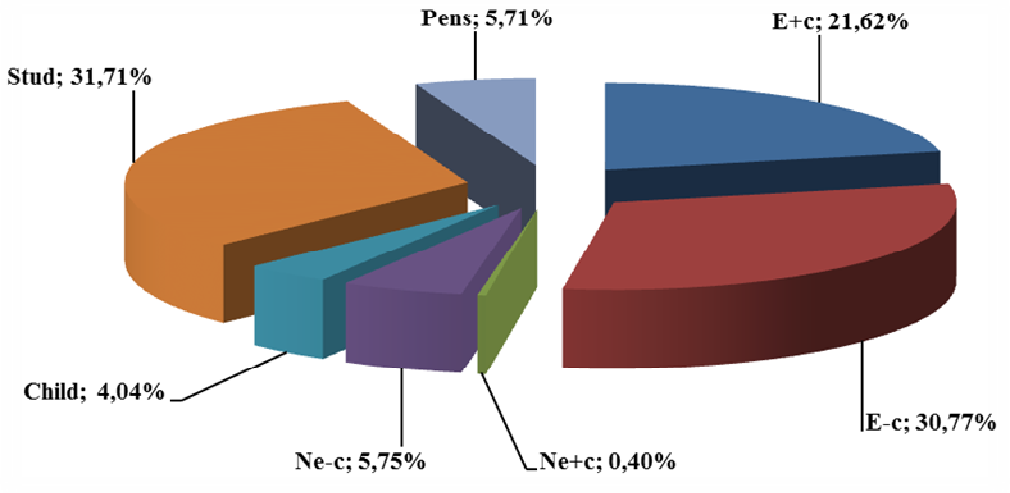

Figure 3. Groups of inhabitants (according to traffic behavior)

Fig. 3 shows current division of inhabitants into the groups. The inhabitants are divided by their social and traffic impact on the traffic process. The data from the Statistical Office of the Slovak Republic are divided only by basic social status (employed, unemployed, student,etc). The calculation of the trip generation needs added traffic characteristics. We could compare only the percentual ratio of employees (E + C and E – C) with the data from the Statistical Office. The household survey determined 52.33% of economic active inhabitants of Žilina city, the Statistical Office of the Slovak Republic published 48% ratio for the region of Žilina. The difference is acceptable but the detailed validation is impossible or inaccurate because of car ownership database. Applying traffic police database is the single way to separate economic active inhabitants by car ownership. We have used it for calibration of final results.

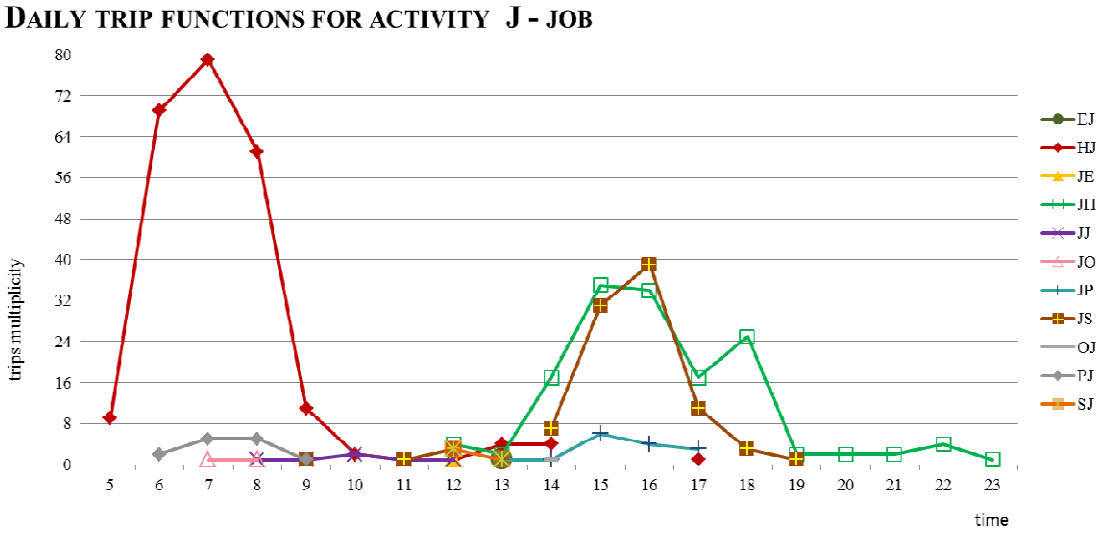

Figure 4. The daily function of Job activity (E – education, H – home, P – private, S – Shop, J – Job, O – Other)

The special attention has been given to evaluating the chains of activities. It means that the activity is defined as an occupation of a person carried out at one location. A chain of activities describes the order of different activities during a person´s run of the day, starting and ending at home, e.g. the chain Home – Job – Shopping – Home (HJSH). Such an order of activities implies movements from one site to another; e.g. from HJSH three trips result: HJ, JS, SH. These data are the most important part of survey and considerably determine the quality of calculated O–D matrices (O – origin, D – destination) of trips divided by the transport mode and the trip purpose [3].

The hourly multiplicity of trips during one work day is one of the most important results from the household mobility survey. Fig. 4 shows the typical behaviour of economic active inhabitants in relation to the Job. Presented values result from one small resident area. The functions reliably copy the morning and afternoon peak hours.

7. Planned Household Survey in Martin

Martin is a city in northern Slovakia, situated on the Turiec river between the Malá Fatraand Veľká Fatra mountains, near the city of Žilina. The population is about 58,000, which makes it the eighth largest city in Slovakia. It is the centre of the Turiec region and the District of Martin.

Our Department of Highway Engineering is the main partner for development of the new traffic plan for vision of 20 years. The household mobility survey of this area will be the next step. We would like to carry out the survey during the summer 2012. We expect the results comparable to Žilina because of the proximity of sites (20 km).

8. Conclusion

There are no any definite standards for household travel surveys in Slovakia. The article presents the problems with organization of household mobility survey. The detailed preparation is the base how to manage the whole survey performance. The questionnaire has to be exact, easy to understand and correctly filled. The determination of credible sample is not so easy and the survey designer must to be sure of the sample sufficiency.

Evaluated household mobility survey results have to be used as demand input data for the calculation of trips generation. We have expected that other methods of data gathering like “face to face” method could be more effective but that has not been a correct assumption. The involvement of inhabitants in data gathering is not sufficient. In general, people want to see the final results, plans and projects.

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